tinguished by its greyish orange to brownish orange pileus, its dense, whitish universal veil, and its farinaceous taste and odor; *C. avellaneus* is distinguished by its pale-avellaneous, finely tomentose pileus and its mild odor and taste.

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GALIUM MEXICANUM (RUBIACEAE) OF CENTRAL AMERICA AND WESTERN NORTH AMERICA

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Galium mexicanum Kunth, in the present expanded sense, occurs in mountainous areas from Panama northward and westward to the state of Washington near the Canadian border (fig. 1) and on Socorro Island. It has not been collected in northeastern Mexico nor in Baja California.

The species was described in 1818 by Kunth (type near Guanajuato) with *"foliis octonis"*. In 1849, Gray published *Galium asperrimum* (type from New Mexico) with *"foliis omnibus senis"* and with some considerable floral differences, which he did not mention. He followed this in 1880 with *G. asperrimum* var. *asperulum* from California, based principally on leaf characters. In 1898, Greenman named two varieties of *G. mexicanum,* namely var. *glabratum* from Oaxaca, based on lack of hairs, and var. *platyphyllum,* based on leaf shape and indumentum, with citation of specimens from Chiapas, Oaxaca, and Jalisco. There are thus currently five names, of which I propose to recognize the first three, while changing the status of *G. asperrimum* Gray and its var. *asperulum* Gray to subspecies of *G. mexicanum*. A new subspecies has been added,

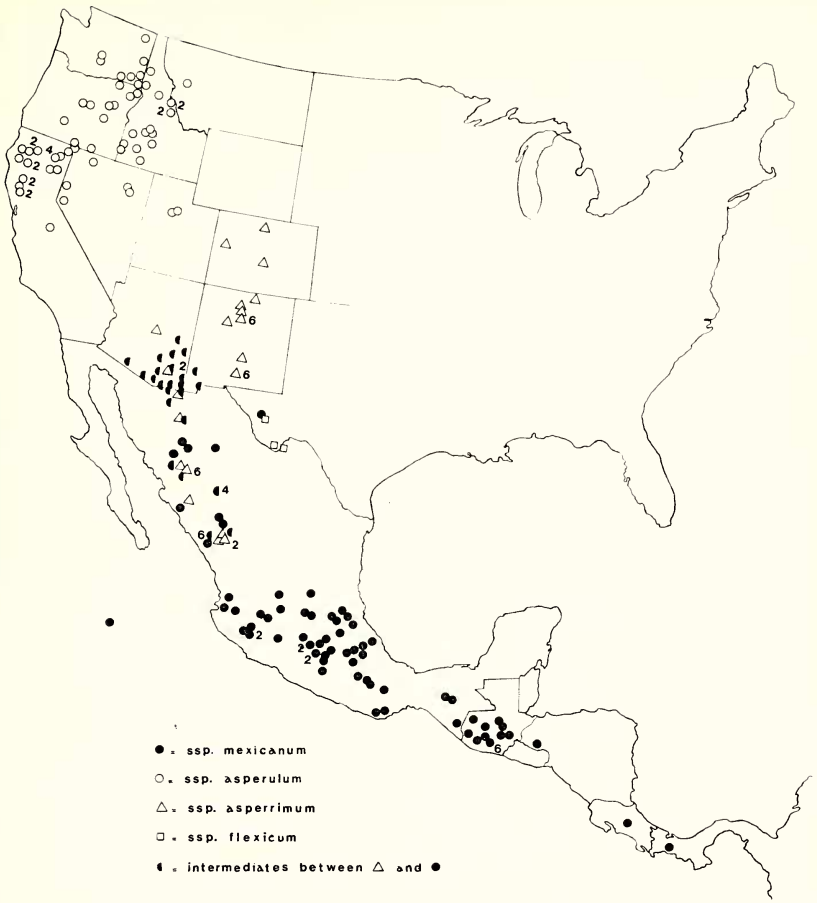

FIG. 1. Distribution of the subspecies of *Galium mexicanum*. Numbers (2, 4, and 6) refer to diploid, tetraploid, and hexaploid chromosome counts.

and the Greenman varietal names are treated as synonyms of ssp. *mexicanum*.

Galium mexicanum is a perennial herb with 5–12 "leaves" at each node (most commonly 6), few to many aculeolate hairs on stems and leaves, perfect flowers having generally, but not always, campanulate corollas, and fruits with well developed (fig. 2 A′, G′) or obscure (fig. 2 B′) uncinate hairs. Where the hairs are obscure, the fruits appear to be tuberculate, although hairs are visible under a dissecting microscope. Very rare individuals (as in perhaps all *Galium* species) have glabrous ovaries and fruits (fig. 2 E).

Although the number of leaves to a node varies in all of the subspecies, the character is somewhat clinal, the tendency being toward a lower number in the northern subspecies and a higher in the southern sub-

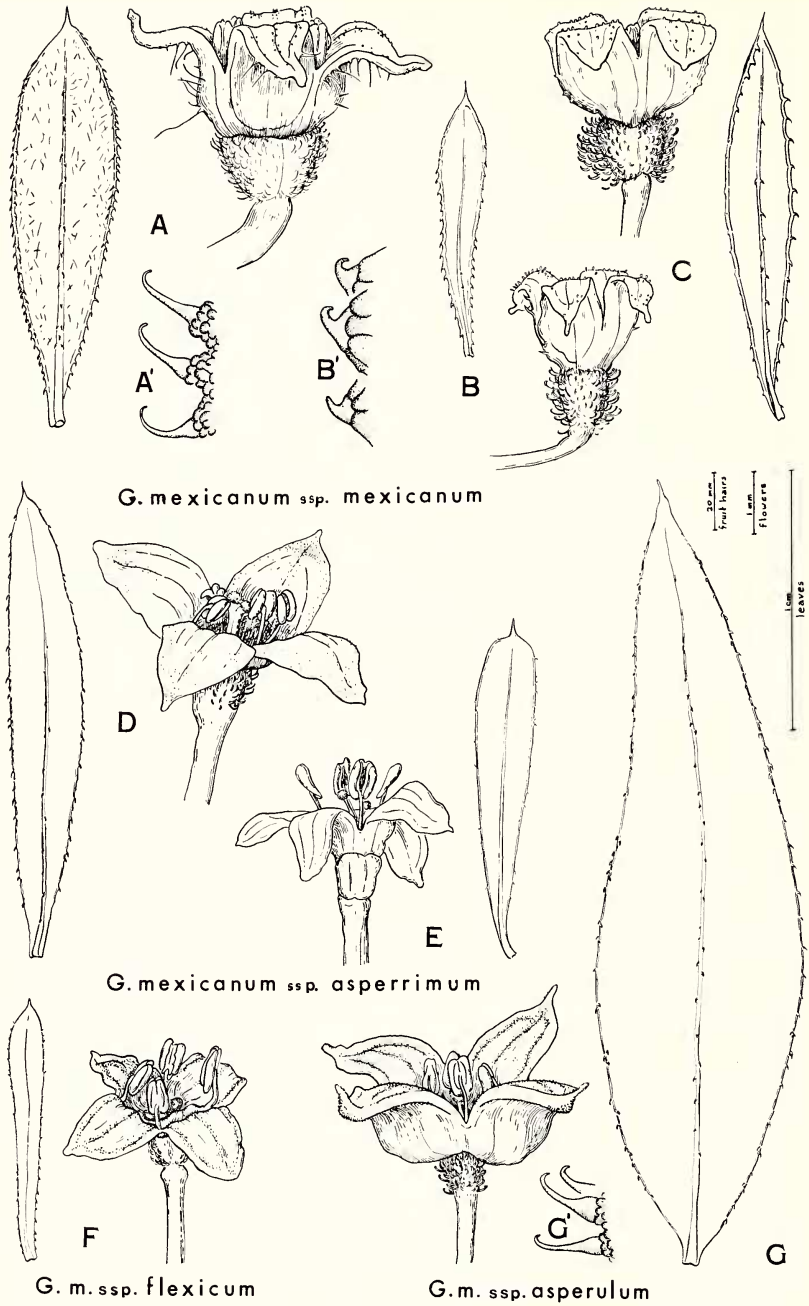

FIG. 2. Representative leaves, flowers, and fruit hairs of *Galium mexicanum*. A-C, ssp. *mexicanum*; D-E, ssp. *asperrimum*; F, ssp. *flexicum*; G, ssp. *asperulum*.

species. The commonest and apparently the "basic" number for *G. mexicanum* throughout is six leaves per node (i.e., two leaves and four stipules), with five to ten not uncommon. Supernumerary leaves occur most often where strong branches arise. The *"foliis octonis"* of Kunth and the *"foliis omnibus senis"* of Gray are both over-simplifications, although Gray was the more nearly correct.

Leaf shape is also somewhat clinal. The leaves of ssp. *asperulum* of the north are thin and generally elliptical or lanceolate, being broadest at or below the middle, in contrast with the often strongly oblanceolate, often leathery, leaves of ssp. *mexicanum* in the south, and in moderate contrast with those of ssp. *asperrimum* of the middle latitudes. Within ssp. *mexicanum* the leaves, although nearly always broadest above the middle, vary greatly in shape, from nearly linear to broadly oblanceolate, without relation to floral characters or geographic location. Hence, Greenman's var. *platyphyllum,* based on a miscellaneous collection of broad-leaved specimens from various localities, is untenable. Leaves in the northern plants are demonstrably larger on the average, and the internodes correspondingly smaller, than in the southern plants (Table 1).

Kunth gave an adequate description of the flowers of *G. mexicanum.* Gray, however, said little about the flowers of *G. asperrimum* and essentially nothing about those of var. *asperulum*; yet flower characters offer the most satisfactory basis for separating these taxa from ssp. *mexicanum* (see key). These flower differences are, in fact, sufficiently impressive that, were it not for massive intergrading in Durango, Chihuahua, Sonora, and Arizona, it would seem reasonable to follow Gray's plan, with a separate species (*G. asperrimum*) typified in New Mexico and a variety (*asperulum*) typified in California.

Galium mexicanum does not divide neatly and easily into subspecies, although many local genetic races exist, as indicated, for example, by rotate corollas near Espinazo del Diablo in Durango, "tuberculate" fruits in the Chiricahua and Huachuca mountains, Arizona, and red or pink corollas in Guatemala and Chiapas.

Separation of ssp. *asperulum,* geographically removed in the far northwest corner of the range, seems clearly desirable, although the morphological characters that separate it are subtle. The establishment of a new subspecies in northern Coahuila and western Texas also seems justified, despite the relatively small area that it occupies, because its range is marginal to the whole and the morphological characteristics are striking and consistent within that range. Subspecies *asperrimum,* on the other hand, is more open to question. In Colorado and New Mexico, except in the southwest corner (Grant Co.), this subspecies is consis-

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A, Jalisco, *McVaugh 11679;* A', Puebla, *Nicolas s.n.*; B, Oaxaca, *Iltis 1151*; B', Arizona, Huachuca Mts., *Lemmon 3013*; C, Distrito Federal, *Pringle 6518*; D, New Mexico, *Wooton s.n.*; E, Chihuahua, *Dempster 4390*; F, Texas *Palmer 35812*; G, California, *Dempster 4444.*

TABLE 1. COMPARISON OF LEAF LENGTH AND INTERNODE INDEX OF SUBSPECIES OF GALIUM MEXICANUM. Number refers to the number of collections measured. Leaf length is the overall average measurement of the longest available leaf in each collection. The internode index is an overall average based on measurement of the longest three consecutive internodes on the leafy portion of the plant, divided by the longest contiguous leaf.

	Number	Leaf length	Internode index
ssp. *asperulum*	113	2.7 cm	6.0
ssp. *asperrimum*	50	1.7 cm	7.1
intermediates	96	1.7 cm	9.0
ssp. *mexicanum*	163	1.5 cm	9.9

tently distinct from ssp. *mexicanum*, on the basis of floral characters. It also appears in various places in Arizona and the Sierra Madre Occidental, surrounded, however, by intermediate forms. Throughout the large area including Durango, Chihuahua, Sonora, Arizona, and western Texas, corollas vary from deeply cut and spreading to more or less urceolate, with more or less sharply reflexed lobes, and the stamens are more or less conspicuous. Within this same area, however, some character expressions that are found farther south do not occur, namely pilose or colored corollas, pilose stems and lower leaf surfaces, and leathery leaves.

Although there seems to be no perfect resolution of the taxonomic problem posed by such a mass of intermediate forms, it does seem clear that the plants of New Mexico and Colorado, and of some localities in the Sierra Madre Occidental, should neither be included with those of the northwest (ssp. *asperulum*), which they somewhat resemble, nor with those of southern Mexico. If, however, a ssp. *asperrimum* is recognized, as it seems it must be, such recognition should be qualified by stating that, although nicely distinct in Colorado and New Mexico, it intergrades with ssp. *mexicanum* from southern Arizona to southern Durango.

The question arises as to whether ssp. *asperrimum* is an incipient species or an old one in the process of merging with ssp. *mexicanum*. Although one might incline toward the latter interpretation, the chromosome situation seems to contradict it. On the distribution map (fig. 1), the figures 2, 4, and 6 represent diploid, tetraploid, and hexaploid populations ($x = 11$). It is apparent that the situation is complex and that many more chromosome counts are needed for an adequate interpretation. From available evidence, it may be suggested, however, that ssp. *asperulum*, with one tetraploid and twelve diploid counts, is an ancient taxon and ssp. *mexicanum* as represented in central Mexico, with three diploid counts, is another. Since populations of ssp. *asperrimum* in New Mexico, where it is typified, and again in the Creel area of Chihuahua, are hexaploid, it cannot be considered ancient, but rather comparatively recent, and perhaps independently derived in several places. It should be noted that in the Durango area one diploid was judged to be of ssp. *asperrimum* on a morphological basis. It should be

mentioned also that the hexaploid collection from Durango was too young to have flowers and might, therefore, be assignable to ssp. *asperrimum* rather than to ssp. *mexicanum*. It seems likely that the whole central population, at least from Durango north into Colorado, represents an evolutionary mingling, with perhaps frequent polyploidy, between the several rather different diploids currently known, besides others not yet recognized.

Key to subspecies of *Galium mexicanum*.

Leaves lanceolate to elliptical, rarely a little oblanceolate, but generally broadest at or below the middle, the largest commonly (1.3)2–4(5) cm long; fruits smooth, not noticeably tuberculate beneath the hairs; corollas white, glabrous, the lobes spreading, the anthers usually visible.....ssp. *asperulum*

Leaves narrowly elliptical or linear to broadly oblanceolate, usually broadest above the middle, the largest commonly 1–2(3) cm long; fruit hairs arising from tubercles; corollas white or colored, glabrous or pilose, the lobes spreading or more or less erect from the sinuses, the anthers visible or often hidden.

Corollas white, pink, or red, sometimes pilose, often cleft about halfway, the lobes more or less erect, then sharply reflexed, the throat usually cupped or, together with the lobes, often urceolate; stamens generally included; stems and lower surface of leaves often set with long straight hairs; leaves thin or often leathery, the marginal hairs stout, retrorse.....ssp. *mexicanum*

Corollas white, not pilose, cleft usually more than halfway, the lobes spreading, not sharply reflexed, the throat flaring to nearly rotate; stamens often exserted; stems and leaves without long straight hairs; leaves thin, the marginal hairs retrorse or antrorse.

Leaves narrowly elliptical to broadly oblanceolate, the marginal hairs retrorse; flowers many, in elaborate, usually loose, terminal bracteose inflorescences and on lower lateral branches; true pedicels not exceeding 8 mm.....ssp. *asperrimum*

Leaves linear to narrowly oblanceolate, the marginal hairs retrorse near leaf base, antrorse on the apical half of the leaf; inflorescence much reduced, the flowers few, often in 3's; true pedicels often very long (to 20 mm).....ssp. *flexicum*

GALIUM MEXICANUM Kunth in HBK, Nov. Gen. et Sp. 3:337. 1818. TYPE: Protologue cites a collection from near Guanajuato by Humboldt and Bonpland. Dr. A. Lourteig was unable to find the Humboldt and Bonpland type at P. It is to be hoped that the specimen will some day be found, but until that occurs it seems desirable to choose a neotype. Considering the local variability of the species, it is important that such neotype be from the type locality, i.e. "prope Guanaxuato,

alt. 1070 hex.". I have seen only three specimens from the state of Guanajuato, two of them from near Guanajuato city. Of these, one is incomparably better than the other in being more complete, in having fuller data and in conforming better to the original description. I therefore designate it as the neotype: 18 miles east of Guanajuato in (sic) road to Dolores Hidalgo, 17 Aug 1957, *Solbrig and Ornduff 4540* (UC).

GALIUM MEXICANUM Kunth ssp. MEXICANUM.

Galium mexicanum var. *glabratum* Greenm., Contr. Gray Herb. n. ser. 14:458. 1898. TYPE: Oaxaca, west slope Mt. Zempoaltepec, *Nelson 583*. Holotype: US!

Galium mexicanum var. *platyphyllum* Greenm., Contr. Gray Herb, n. ser. 14:458. 1898. TYPE: Chiapas, near San Cristóbal, *Nelson 3165*. Holotype: US!

Moist slopes, meadows, cliffs, and barrancas; mostly dense or open pine-oak forest, but sometimes in chaparral, or with *Abies, Juniperus, Opuntia,* or palms. (970)1200–3500 m. Panama, Costa Rica, Honduras, Nicaragua, Guatemala, south and central Mexico, northward in the Sierra Madre Occidental to eastern Sonora and southwestern Arizona; western Texas; Socorro Island. In Durango and northward, it intergrades with ssp. *asperrimum*. $2n = 22$, 44, 66 (see Table 2).

Galium mexicanum Kunth ssp. **asperulum** (Gray) Demp., comb. et stat. nov.—*Galium asperrimum* var. *asperulum* Gray, Bot. Cal. 1:284. 1880.—*Galium asperulum* (Gray) Rydb., Fl. Rocky Mts. 809. 1917.—*Galium mexicanum* var. *asperulum* (Gray) Demp., Brittonia 10:187. 1958. TYPE: California, Mariposa Co., Mariposa Sequoia Grove, *Bolander 6350*. Holotype: GH!; isotypes: UC! US!.

Wet places near streams, springs, and seeps; (150)950–3000 m. Pacific northwest from Washington and northern California east to western Montana and Utah. $2n = 22$, 44 (see Table 2).

Galium mexicanum Kunth ssp. **asperrimum** (Gray) Demp., comb. et stat. nov.—*Galium asperrimum* Gray, Pl. Fendl. 60. 1879. TYPE: New Mexico, Santa Fe, *Fendler 289*. Holotype: GH; isotypes: MO!, UC!

Wet ground along streams, and on moist slopes and meadows, 1950–3000 m. Colorado and New Mexico; isolated localities in Arizona and in the Sierra Madre Occidental in Sonora, Chihuahua, and Durango, where it also intergrades with ssp. *mexicanum*. $2n = 22$, 66 (see Table 2).

Galium mexicanum Kunth ssp. **flexicum,** ssp. nov. Planta *Galium concinnum* simulans, foliis senis tenuibus anguste oblanceolatis, floribus paucis pedicellis longis capillaribus insidens, sed corolla campanulata

TABLE 2. CHROMOSOME NUMBERS IN GALIUM MEXICANUM. Collection numbers are mine unless otherwise indicated. Vouchers are in JEPS or UC. See also Figure 1.

Galium mexicanum ssp. *asperulum.*

$2n = 22$. California, Lake Co., Rice Creek Road at Deer Creek, *4435,* Twin Springs S of Sheetiron Mtn., *4437,* Rice Creek Rd. N of Sheetiron Mtn., *4438*; Glenn Co., Big Cottonwood Flat, *Eckenwalder 203,* Cottonwood Glade, *4439*; Trinity Co., along Mad River S of Ruth, *4441*; Shasta Co., Quartz Spring on road to French Gulch, *4444*; Siskiyou Co., N Fork Coffee Creek, *4443,* Big Springs of McCloud River, *4446.* Idaho, Lemhi Co., Pierce Creek, *4465,* Panther Creek Road, *4467.* Montana, Ravalli Co., N of Sula, *4463.*

$2n =$ ca 44. California, Plumas Co., Swain Mtn. road 1.9 mi from Hwy 36, *4447.*

Galium mexicanum ssp. *asperrimum.*

$2n = 22$. Durango, W of Durango city, *4395.*

$2n = 66$. New Mexico, Otero Co., Sacramento Mts., *4385.*

$2n =$ ca. 66. New Mexico, Santa Fe Co., Sangre de Cristo Mts., *4382.* Chihuahua, Creel, *4390.*

Galium mexicanum ssp. *mexicanum.*

$2n = 22$. Arizona, Graham Co., Pinaleño Mts., *4407.* Jalisco, Hwy 10 S of junction with road to Tuxpan, *Weller 667.* Michoacan, N of San Felipe los Alzati, *Weller 739.* Mexico State, 8 mi S of Temescaltepec, *Weller 600.*

$2n = 44$. Chihuahua, hills W of Santa Barbara, *4399.*

$2n = 66$. Durango, Route 40 near Sinaloa state line, *Cruden 1170* (no flowers).

$2n =$ ca 66. Guatemala, Sacatepequez, Volcán de Agua, *Cruden 1558.*

fauce non profunda lobis extendentibus, fructibus ovariisque pilis uncinatis obtectis.

TYPE: Texas, Brewster Co., Chisos Mts., 18 Aug 1931, *C. H. Mueller 8281.* Holotype: TEX!; isotypes: GH!, MICH!, NY! The name refers to the Big Bend of the Rio Grande.

Stems slender, flexible, minutely scabrous; leaves 6 at a node, linear to mostly narrowly oblanceolate, 1–2 cm long, the margins scabrous, the lower hairs retrorse, the upper mostly antrorse; inflorescence much reduced, the flowers few (often in 3's); pedicels and branchlets of the inflorescence capillary, the true pedicels often exceptionally long (to 20 mm in fruit); corollas glabrous, cleft below the middle, the throat flaring, the lobes spreading; fruit hairs abundant, short, stout.

Moist ledges and shady woods along stream banks and springs; 1800–2400 m. Del Carmen Mountains, Coahuila; Chisos Mountains, Brewster Co., and Davis Mountains, Jeff Davis Co., Texas. Although there is some uncertainty about the situation in Jeff Davis Co., the new subspecies appears to be allopatric to the other subspecies.

This taxon includes all collections from the Big Bend region of Texas and Coahuila and a few collections from Jeff Davis Co. (the latter all from "upper Limpia Canyon", *E. J. Palmer 30698, 30807, 34366*). Although the general appearance of the plants, with slender flaccid leaves and long capillary pedicels, is precisely that of *G. concinnum* T. & G. from the eastern and middle western United States, it differs significantly in having fruits with curved or hooked hairs and in the more definitely

campanulate corollas. One is tempted to interpret it as being of hybrid origin, an interpretation nicely supported by the orientation of the marginal hairs on the leaves. *Galium mexicanum* in general has usually many stout retrorse prickles on the leaf margins. In *G. concinnum,* however, although the leaves are nearly glabrous, such hairs as can be found are antrorse. In *G. mexicanum* ssp. *flexicum,* the situation is intermediate, the relatively slender hairs on the basal half of the leaf being basally directed, and those on the apical portion being apically directed. The presence of hairs on the ovaries is considered to be critical in assigning ssp. *flexicum* to *G. mexicanum* rather than to *G. concinnum.*

The Palmer collections from the Limpia Canyon, Jeff Davis Co., differ from those of the Del Carmen and Chisos mountains only in that the marginal leaf-hairs are a little stouter and all basally directed. On the other hand, they differ sharply from plants of Mt. Livermore and elsewhere in the Davis Mountains, all of which are clearly ssp. *mexicanum.*

I thank Rimo Bacigalupi for editing the Latin.

VEGETATION SURROUNDING KINGS LAKE BOG, WASHINGTON

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This communication describes vegetation surrounding a small bog lake in lowland King County, Washington. We tested the hypothesis that the plants comprising vegetation surrounding this bog are arranged in zones rather than continuously in response to environmental gradients.

Vegetation can be analyzed by two distinct approaches. Numerical classification methods group samples into categories and emphasize similarities within and differences between categories. Ordination methods arrange samples sequentially based on environmental data or on compositional similarity of the vegetation itself or both. Both methods can contribute to the understanding of vegetation and the causes of vegetation organization.

Gauch and Whittaker (1972) documented the growing realization of many ecologists that simple geometric ordinations are superior to more elegant methods in several ways. They are mathematically straightforward and the results are usually more reliable. Ordination approaches have been successfully applied to many situations but seem best adapted to those in which beta diversity is low and vegetation scale being investigated is intermediate (Gauch, 1973).